Claims

What is claimed is:

1. A method for reconstructing relative phase information in an iterative misfocused image correction process, said method comprising:

(a) receiving misfocused image data from an image source, said image data comprising image amplitude information and lacking relative phase information;

(b) generating a trial power value for a fractional Fourier transform correction operation according to an optimization algorithm;

(c) determining a trial fractional Fourier transform correction operation based upon said trial power value;

(d) determining trial phase restoration information based upon said trial power value;

(e) applying said trial phase restoration information and said trial fractional Fourier transform correction operation on said image data to correct a level of misfocus of said image data; and

(f) determining if a desired level of correction of said misfocus of said image data has been achieved, wherein if said desired level has not been achieved, then a new value for said power value of said fractional Fourier transform correction operation is generated according to said optimization algorithm and said operations (c) through (f) are repeated.

2. The method according to claim 1, wherein said trial phase restoration information is determined by the difference between said trial power value and an in-focus power of said fractional Fourier transform correction operation.

3. The method according to claim 2, wherein said in-focus power is a power that causes a fractional Fourier transform raised to said in-focus power to be equivalent to a Fourier transform composed with itself.

4. The method according to claim 1, wherein said trial fractional Fourier transform correction operation is determined by at least one pre-computed fractional Fourier transform operation.

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5. The method according to claim 1, wherein said trial fractional Fourier transform correction operation is determined using a plurality of pre-computed fractional Fourier transform operations.

6. The method according to claim 1, wherein said trial fractional Fourier transform correction operation is determined by a direct calculation from a definition parameterized by said trial power value.

7. The method according to claim 1, wherein said trial phase restoration information is determined by an operation using at least one pre-computed phase restoration value.

8. The method according to claim 1, wherein said trial phase restoration information is determined by an operation using a plurality of pre-computed phase restoration values.

9. The method according to claim 1, wherein said trial phase restoration information is determined by a direct calculation from a definition parameterized by said trial power value.

10. The method according to claim 2, wherein said trial fractional Fourier transform correction operation is of period four and said in-focus power is two.

11. The method according to claim 1, wherein said image source only conveys amplitude information.

12. The method according to claim 1, wherein said misfocused image data is selected from the group consisting of an electronic signal, data file, photography paper, photographic slide, motion photography, decompressed digital image, video frame, video stills, and motion video.

13. The method according to claim 1, wherein said image source renders said image data from an electronic signal source.

14. The method according to claim 1, wherein said image source renders said image data from a photographic media source.

15. The method according to claim 1, wherein said misfocused image data comprises motion video.

16. The method according to claim 1, wherein said misfocused image data comprises a data file.

17. The method according to claim 1, wherein said misfocused image data comprises motion photography.

18. The method according to claim 1, wherein said misfocused image data has been stored and retrieved.

19. The method according to claim 1, wherein said determining operation (f) is manually performed by a human operator.

20. The method according to claim 1, wherein said determining operation (f) is performed by an automatic process.

21. The method according to claim 1, wherein said trial phase restoration information is determined by performing mathematical operations on said trial fractional Fourier transform correction operation.

22. The method according to claim 1, wherein said trial phase restoration information is determined by reconfiguring calculations used to determine said trial fractional Fourier transform correction operation.

23. The method according to claim 1, wherein said trial phase restoration information is determined by calculations involving at least one partial result that is also used to determine said trial fractional Fourier transform correction operation obtained in operation (c).

24. The method according to claim 1, wherein said trial fractional Fourier transform correction operation is determined by composing a plurality of pre-computed fractional Fourier transform operations, wherein each of said plurality of said pre-computed fractional Fourier transform correction operations correspond to associated power values that are selected binary fractions.

25. The method according to claim 24, said method further comprising:
selectively choosing which transform operations of said plurality of pre-computed fractional Fourier transform operations are to be used in said composing, wherein said choosing is determined by the value of digits in a binary fraction representation of said trial power value generated in operation (b).

26. The method according to claim 1, wherein said trial phase restoration information is determined by composing a plurality of pre-computed phase restoration values, wherein said plurality of said pre-computed phase restoration values correspond to associated power values that are selected binary fractions.

27. The method according to claim 26, said method further comprising:
selectively choosing which transform operations of said plurality of pre-computed fractional Fourier transform operations are to be used in said composing, wherein said choosing is determined by the value of digits in a binary fraction representation of said trial power value generated in operation (b).

28. The method according to claim 1, wherein said image data is obtained from an electron microscopy device.

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29. The method according to claim 28, wherein said trial phase restoration

2 information and said trial fractional Fourier transform correction operation are applied on a

selected portion of said image data to correct a level of said misfocus at said selected portion

4 of said image data.

30. The method according to claim 1, wherein said trial phase restoration

2 information and said trial fractional Fourier transform correction operation are applied on a

selected portion of said image data to correct a level of said misfocus at said selected portion

4 of said image data.

31. The method according to claim 1, said method further comprising:

2 providing said corrected image data to an image observation element.

32.   A system for reconstructing relative phase information in an iterative

2   misfocused image correction process, said system comprising:

an image source providing misfocused image data, said misfocused image data

4   comprising image amplitude information and lacking relative phase information;

at least one processor adapted to provide said iterative misfocused image correction

6   process according to a method comprising:

(a)   generating a trial power value for a fractional Fourier transform

8   correction operation according to an optimization algorithm;

(b)   determining a trial fractional Fourier transform correction operation

10   based upon said trial power value;

(c)   determining trial phase restoration information based upon said trial

12   power value;

(d)   applying said trial phase restoration information and said trial

14   fractional Fourier transform correction operation on said image data to correct a level

of misfocus of said image data; and

16   (e)   determining if a desired level of correction of said misfocus of said

image data has been achieved, wherein if said desired level has not been achieved,

18   then a new value for said power value of said fractional Fourier transform correction

operation is generated according to said optimization algorithm and said operations

20   (b) through (e) are repeated.

33.   The system according to claim 32, wherein said trial phase restoration

2   information is determined by a direct calculation from a definition parameterized by said trial

power value.

34.   The system according to claim 32, wherein said image source only conveys

2   amplitude information.

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35.   The system according to claim 32, wherein said misfocused image data is

2   selected from the group consisting of an electronic signal, data file, photography paper,

photographic slide, motion photography, decompressed digital image, video frame, video

4   stills, and motion video.

36.   The system according to claim 32, wherein said misfocused image data

2   comprises motion video.

37.   The system according to claim 32, wherein said misfocused image data

2   comprises motion photography.

38.   The system according to claim 32, wherein said trial phase restoration

2   information is determined by performing mathematical operations on said trial fractional

Fourier transform correction operation.

39.   The system according to claim 32, wherein said trial phase restoration

2   information is determined by reconfiguring calculations used to determine said trial

fractional Fourier transform correction operation.

40.   The system according to claim 32, wherein said trial phase restoration

2   information and said trial fractional Fourier transform correction operation are applied on a

selected portion of said image data to correct a level of said misfocus at said selected portion

4   of said image data.

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41.   A method for reconstructing relative phase information in a misfocused image

2   correction process, said method comprising:

(a)   receiving misfocused image data from an image source, said image data

4   comprising image amplitude information and lacking relative phase information;

(b)   generating a power value for a fractional Fourier transform correction

6   operation according to a power calculation algorithm;

(c)   determining a fractional Fourier transform correction operation based upon

8   said power value;

(d)   determining phase restoration information based upon said power value; and

10   (e)   applying said phase restoration information and said fractional Fourier

transform correction operation on said image data to correct a level of misfocus of said image

12   data.

42.   The method according to claim 41, said method further comprising:

2   repeating operations (b) through (e) until a desired level of correction of said

misfocus of said image data has been achieved.

43.   The method according to claim 41, wherein said power calculation algorithm

2   generates said power value according to an optimization algorithm.

44.   The method according to claim 41, wherein said phase restoration information

2   is determined by a direct calculation from a definition parameterized by said trial power

value.

45.   The method according to claim 41, wherein said image source only conveys

2   amplitude information.

46.   The method according to claim 41, wherein said misfocused image data is

2   selected from the group consisting of an electronic signal, data file, photography paper,

photographic slide, motion photography, decompressed digital image, video frame, video

4   stills, and motion video.

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47.   The method according to claim 41, wherein said misfocused image data

2   comprises motion video.

48.   The method according to claim 41, wherein said misfocused image data

2   comprises motion photography.

49.   The method according to claim 41, wherein said phase restoration information

2   is determined by performing mathematical operations on said trial fractional Fourier

transform correction operation.

50.   The method according to claim 41, wherein said phase restoration information

2   is determined by reconfiguring calculations used to determine said trial fractional Fourier

transform correction operation.

51.   The method according to claim 41, wherein said phase restoration information

2   and said fractional Fourier transform correction operation are applied on a selected portion of

said image data to correct a level of said misfocus at said selected portion of said image data.

52.   A system for reconstructing relative phase information in a misfocused image

2   correction process, said system comprising:

an image source providing misfocused image data, said misfocused image data

4   comprising image amplitude information and lacking relative phase information;

at least one processor adapted to provide said misfocused image correction process

6   according to a method comprising:

(a)   generating a power value for a fractional Fourier transform correction

8   operation according to a power calculation algorithm;

(b)   determining a fractional Fourier transform correction operation based

10   upon said power value;

(c)   determining phase restoration information based upon said power

12   value; and

(d)   applying said phase restoration information and said fractional Fourier

transform correction operation on said image data to correct a level of misfocus of

14   said image data.

53.   The system according to claim 52, wherein operations (a) through (d) are

2   repeated until a desired level of correction of said misfocus of said image data has been

achieved.

54.   The system according to claim 52, wherein said power calculation algorithm

2   generates said power value according to an optimization algorithm.

55.   The system according to claim 52, wherein said phase restoration information

2   is determined by a direct calculation from a definition parameterized by said trial power

value.

56.   The system according to claim 52, wherein said image source only conveys

2   amplitude information.

57. The system according to claim 52, wherein said misfocused image data is
2 selected from the group consisting of an electronic signal, data file, photography paper, photographic slide, motion photography, decompressed digital image, video frame, video
4 stills, and motion video.

58. The system according to claim 52, wherein said misfocused image data
2 comprises motion video.

59. The system according to claim 52, wherein said misfocused image data
2 comprises motion photography.

60. The system according to claim 52, wherein said phase restoration information
2 is determined by performing mathematical operations on said trial fractional Fourier transform correction operation.

61. The system according to claim 52, wherein said phase restoration information
2 is determined by reconfiguring calculations used to determine said trial fractional Fourier transform correction operation.

62. The system according to claim 52, wherein said phase restoration information
2 and said fractional Fourier transform correction operation are applied on a selected portion of said image data to correct a level of said misfocus at said selected portion of said image data.